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Do Learning Management Systems Really Manage Learning?

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Do Learning Management Systems Really Manage Learning?

by

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Report

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Abstract

Do Learning Management Systems Really Manage Learning?

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This report explores if learning management systems (LMS) help educators design online and blended learning experiences. I reviewed the science of learning and development, foundational learning theories, and popular pedagogical approaches. I then studied learning management systems and analyzed their features. I discovered that the most popular LMS were designed to be generic and flexible, so that any teaching and learning strategies could be implemented. But many other LMS focus on some particular teaching and learning strategies and guide teachers and learners through the process. After the investigation, I recommended that teachers decide if they should use one of the popular or generic LMS or whether they need more support implementing particular approaches in a specialized LMS. I also recommended that all LMS should support more student centered learning and investigate whether including tools to facilitate instructional design with particular approaches could be valuable.

Keywords: Learning Management Systems, LMS, Science of Learning and Development, Behaviorism, Cognitivism, Constructivism, Pedagogy, Personalized Learning, Project-Based Learning, Social Emotional Learning

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Chapter 1: Introduction and Method

After learning about the foundational learning theories, the learning sciences, and popular pedagogical approaches, I began wondering about learning management systems (LMS). I have worked in K-12 education for fifteen years and have not seen wide scale adoption of LMS. And when I investigated the features of LMS, I did not see many of the things I had learned about in graduate school about designing digital learning environments. My hypothesis is that LMS do not contain all features necessary to drive learning in students or help teachers implement popular pedagogical approaches. The method for this investigation included the following steps:

1. Investigate how people learn by studying the science of learning and development, especially the role of cognition.
2. Investigate how teachers teach by studying the foundational learning theories and popular pedagogical approaches like personalized learning, project-based learning, and social emotional learning.
3. Investigate the current features of learning management systems and whether they align to the science of learning and development, foundational learning theories, or popular pedagogical approaches.
4. Make a list of features that LMS should have if they are designed around how people learn and how people teach.

5. Research popular LMS platforms and see which features are present and which features are missing.
6. Make recommendations to educators about using LMS platforms and also to LMS companies about possible new features.

Chapter 2: Learning

Since the first word in "learning management system" is learning, I began with investigating how learning happens. The best source I found is a meta analysis of more than eighty sources on how people learn. It is divided up into four factors that impact learning: Cognition, Motivation, Identity, and Individual Variability (Transcend, 2020). The following is a summary of these factors (Table 1).

Table 1: Designing for Learning Primer (Transcend, 2020)

Table 1: Designing for Learning Primer (Transcend, 2020)	
Factors that Impact Learning	**Summary**
Cognition	The basic way we learn begins with memory. When something happens, we process it in our short term memory and try to encode it in our long term memory. We learn best when we engage in lots of practice retrieving those long term memories and bringing them back to our short term memory to address our immediate needs. There are a few key ways we can help our brains remember more things and apply them: • When we can focus our attention on the thing we are trying to learn or do.

	• When we don't have to learn too many things at the same time (managing cognitive load). • When what we are learning is interesting, meaningful, and related to previous knowledge, which helps the process of encoding them from short term to long term memory. • When we have consistent opportunities to practice skills that are challenging but possible for us to master. • When we receive high quality and timely feedback on the work we do. • When we engage in metacognition to think about the way we think, learn, and process information.
Motivation	To be able to learn something, we have to want to learn it. We have to find the energy to start, use our mental energy to think about it, and keep going until we understand it. There are a few components of learning experiences that help us stay motivated: • When we personally find value in the thing we are learning. • When we believe in ourselves and are confident we will be successful. • When we feel that we have control over the learning and can move at our own pace and challenge level • When our emotional state is consistent and not undergoing trauma, stress, or anxiety.
Identity	When we are learning, we bring our whole selves with us (all of our intersectional identities). How we see ourselves and how others see us impacts our motivation and how we learn (or whether we learn). The following identity characteristics help us learn: • When we are confident that we understand ourselves, and engage in healthy self-talk about our previous, current, and future selves, it is easier to engage in learning (especially if the specific learning is part of our current or future identity). • When we feel a sense of belonging in our general environment and learning environment. • When we don't have to deal with negative identity threats in our environment.
Individual Variability	Every learner is different in various ways. We learn better when the learning environment acknowledges and responds to the differences in appropriate ways. The following factors produce variability in learners that need to be acknowledged.

	• When our life experiences, both good and bad, are acknowledged and incorporated into the learning environment design. • When learning is aligned to what is appropriate for our developmental level. • When our individual learning differences are acknowledged and addressed.

In all of these areas, there are actions that both learners and teachers can take to help the learning process. At the cognitive level, activities like repeated practice and relating new information to previously learned knowledge is crucial. For motivation, relating information that students value is important. A student's identity also impacts learning, and a safe and supportive environment is crucial to learning. Since every learner is different, their life experiences, developmental level, and learning differences need to be acknowledged. Learning management systems should contain some features that support these factors that impact learning. Later in this investigation, I will suggest features that could be added to learning management systems.

The role of cognition is a particularly important part of the science of learning and development, since it is responsible for how we make and use memories. I was inspired to learn more about memory, and found a great framework called MARGE, which explains activities that help the brain learn and apply new information: motivate, attend, relate, generate, evaluate (Shimamura, 2020). The following table explains each step and how it can inform instruction (Table 2).

Table 2: MARGE: A Whole-Brain Learning Approach for Students and Teachers (Shimamura, 2020)

Table 2: MARGE: A Whole-Brain Learning Approach for Students and Teachers (Shimamura, 2020)		
Factor	**Summary**	**Implications for Instruction**
Motivate	The first step in learning is to be motivated to learn, and one way we can do that is to activate the reward circuit like we do with fun activities, sweets, music, etc.	• Piquing learner curiosity • Relating lessons to the "big picture" concept • Storytelling • Aesthetic questioning, e.g. "do you like this or not?" • Online resources like YouTube videos
Attend	As information is presented to a learner, they need a way to receive and collect that information, which is called attending.	• Take advantage of the first few minutes of a lesson to engage students, so that they are motivated to attend to the facts being presented. • Chunk information into meaningful parts. The "chunk" and "meaningful part" should be selected intentionally. • Take students down a learning path that leads learners from the starting point to the learning goal, similar to a "guided tour" in a museum.
Relate	As we pay attention to new information, our brain relates that new information to things we already know.	• Have students recall what they already know about the topic or a similar topic. • Divide information into "meaningful chunks" and relate them to existing knowledge. • Use mnemonics that are words or images. • Intensely interrogate the topic to categorize, explain why, compare/contrast it with other things, etc.

		• Creating mental pictures and movies
		• Analogies and metaphors
		• Organize concepts into schematics like:
		  ○ Hierarchies
		  ○ Outlines
		  ○ Concept Maps

Generate	To generate information means to retrieve memories from long term memory and reactivate it in short term memory (i.e. things you think about, say, and do).	• Say or express concepts "in your own words" • Do this often (practice) • Space it out so time goes by and you learn other things as well (spiraling) • Use the same organizational schematics from "Relate" with self-generated information.
Evaluate	To evaluate is to use the process of metacognition to think about the way we think.	• Practice generating information from memory and check to see what was is missing • Practice this repeatedly but spacing it out and even alternating different topics.

This specific dive into the cognitive element of learning has so many great suggestions for how learners and teachers can help learning happen. I think it's particularly interesting how many of the recommendations are based on what students should do when presented with new material, regardless of what the "assignment" is from the teacher. There are choices that teachers can make to promote learning and there are habits that students can have that help them learn. Learning management systems can add features to help learners use these strategies beyond the classroom materials and plans that teachers prepare in the system. Furthermore, teacher features can be improved to support learning and development the way the research shows. However, the science of learning and

development is only half the story. There are many philosophies of how learning activities should be designed, and investigating those will help us surface more features that learning management systems should have.

Teaching

When reading through the research about how the brain works, there are a lot of experiments that show how brain activity is activated in different scenarios. Although these scenarios are strategically selected, educators will recognize that there are a lot of different ways to present material and design a learning activity that activates the brain of the student. These different philosophies of teaching are called learning theories, and each one has different ideas of how teachers should teach. Ertmer and Newby (2008) analyzed the prominent learning theories and included specific ways they show up in learning environments (Table 3). I also added some valuable information to Table 3 about one of the theories, constructivism, from Duffy & Cunningham (1996).

Table 3: Behaviorism, Cognitivism, & Constructivism (Ertmer & Newby, 2008; Duffy & Cunningham, 1996)

Table 3: Behaviorism, Cognitivism, & Constructivism (Ertmer & Newby, 2008; Duffy & Cunningham, 1996)		
Learning Theory	**How Learning Happens**	**Teaching and Learning Practices**
Behaviorism	Learning happens when the intended response (behavior) is the result of introducing a specific stimulus. This happens through repetition and tweaking the learning environment to produce the most consistent response.	• Repetitive practice • Use positive reinforcement with rewards and feedback • Use cues, shaping, and practice • Use consistent sequencing and prompts

		• Defining and illustrating concepts • Associating concepts by applying explanations • Chaining, or creating a set procedure of tasks in a sequence • Focus on producing observable and measurable outcomes • Pre-assessment / diagnostic assessment at the beginning of units, which are compared to summative or post-assessments at the end • Focus on mastering early steps before trying to tackle more complex steps
Cognitivism	Learning happens when the individual goes through mental processes to receive, store, and retrieve information in the brain. Information is connected and part of learning is to make those connections between existing knowledge and new information.	• Feedback (not for reinforcement like behaviorists - but knowledge of results) to guide and support accurate mental connections • Focus on the active involvement of the learner in the learning process, including more learner control than behaviorism, metacognitive activities like goal setting, planning, and self-critique • Use of hierarchical analyses to align prerequisite knowledge to new information. Also called cognitive task analysis. • Organizing information using strategies like outlines, summaries,

		advance organizers, graphic organizers, etc. • Provide opportunities and create environments where students can easily recall previously learned material
Constructivism	Learning happens when we are able construct meaning from our own personal experiences. This can happen alone or in a social situation with other learners. Technically, constructivism is a branch of cognitivism. It just focuses more on the learner making sense of the world instead of just cataloging information from the world.	• Situating tasks and examples in real world contexts • Use of apprenticeships where expert performance is modeled and coached • Present multiple perspectives (collaborative learning to develop and share alternative views) • Social negotiation via debates, discussions, finding evidence • Providing guidance on the use of constructive processes (similar to metacognition in cognitivism) • Assist learners to actively explore complex things, which help them think more like an expert in that domain. • Provide opportunities for learners to construct their own understandings and validate them through social negotiation • Focus on the identification of context • Present information many different ways so that learners can experience it

		from different perspectives, situations, modalities, etc. • Using problem solving to infer the information beyond what is given • Assessment focused on application or transfer of knowledge and skills

These learning theories are the most foundational and basic descriptions of how teachers can design learning activities and environments. There are many more branches of these learning theories and more modern theories that can be studied. However, even in this cursory overview, the articles provided dozens of teaching strategies for the different learning theories. Later in this investigation, we will see which of these strategies can be delivered easily through learning management systems.

Although the scholars that contributed to our understanding of the foundational learning theories may disagree with each other, teachers and instructional designers may not be so rigid. There is a concept with a lot of evidence called "systematic eclecticism," which posits that educators use many different strategies from the different learning theories depending on the content being taught and the expectations for the student product or outcomes (Snelbecker,1989). Ertmer & Newby (2008) also noticed this in their research. For example, a single unit can include diagnostic and summative assessments to measure growth (behaviorist), outlines and graphic organizers to understand the content (cognitivist), and an application activity like a group project (constructivist). This makes sense to me, because when I talk to educators about their beliefs about pedagogy, some mention learning theories but many mention other

approaches to teaching content like personalized learning, social emotional learning, etc. I want to investigate some of these popular approaches as well, to see if they align to LMS features.

Each year, the practitioner website TeachThought publishes a study on the biggest trends in education by looking at social media, education websites, and search engines. The top of the website indicates that it has been shared on social media approximately 27,300 times and viewed approximately 125,400 times. Some of the trends are ideas like "growth mindset," others are curricular topics like "digital citizenship," and some are pedagogical approaches. I picked the top three pedagogical approaches to investigate further: personalized learning, project-based learning, and social emotional learning (Heick, 2019). To find out more about these approaches, and how teachers were implementing them, I focused my research on studies that involve teachers and school administrators. The Teacher Resource Center database indexes these types of studies.

Personalized learning is a pedagogical approach that centers on the individual student instead of a standardized content-based approach for all students. One definition comes from the organization LEAP Innovations: "Personalized learning is FOCUSED on, LED with and DEMONSTRATED by the learner, and is CONNECTED to career-relevant, real-world skills and opportunities" (LEAP, 2020). The approach echoes strategies in the science of learning and developments in areas like student agency and acknowledging learning differences. I was curious about teaching and learning practices

in personalized learning, and I found a lot of articles in the Teacher Resource Center database (Table 4).

Table 4: Personalized Learning studies from Teacher Resource Center

Table 4: Personalized Learning studies from Teacher Resource Center		
Study	**Summary**	**Teaching and Learning Practices**
Strengths-based blended personalized learning: An impact study using virtual comparison group (Mccarthy, Liu, & Schauer, 2020)	The study used a strengths-based approach to implementing personalized learning. Student strengths were identified using assessments and conversations, and learning paths were designed to follow those strengths instead of where the learners had gaps.	• Use interviews, surveys, and assessments to find the unique strengths of each student (have to do this repeatedly) • Personalized instruction based on those strengths
Digital curation for promoting personalized learning: A study of secondary-school science students' learning experiences (Tsybulsky, 2020)	When students were given a topic and asked to curate a set of resources that cover the topic, their understanding of the topic was deeper than those who did not.	• Instead of always providing learning materials to students, teachers could give students a topic and allow them to find and curate content • Digital literacy and fact checking tools could help students in content selection
Personalized learning in iSTART: Past modifications and future design. (Mccarthy, Watanabe,	Students were given online texts based on their own personal level using an adaptive technology. Students who participated in this	• Aligning content to what is most appropriate for each student

Dai, & Mcnamara, 2020)	program, especially less-skilled readers, grew more from the pre-test to the post-test than those who did not participate in the program.	• Use adaptive technologies to automate the process
Technology-enabled personalized learning: A promising practice in need of robust research (Huggins & Kellogg, 2020)	Personalized learning is a promising practice that includes competency-based progression, instruction based on individual student needs & interests, standards-aligned, and promotes student ownership.	• Competency-based progressions • Tracks individual student needs and interests • Aligned to academic standards • Promote student ownership
Supporting Personalized Learning through Individualized Learning Plans (Hackmann, Malin, Hamilton, & O'Donnell, 2019)	Individual learning plans are an important component of personalized learning for college and career readiness. They can include exploring, planning, and transitioning.	• Student interest/skill inventories • Career exploration • Reflection • Planning tools for exploration • Planning tools for transitioning

The personalized learning research studies mentioned many teaching and learning practices that we have already seen and also introduced a few new ones. The discussion on understanding each learner has surfaced the need for a student profile that collects information about each student, including their interests, goals, skills, strengths, and areas of growth. Other new ideas include helping students with digital literacy and fact checking, competency-based progression, and planning tools for transition at the end of high school. Later in this investigation we will explore LMS products and see which ones are prepared to support personalized learning in this way.

Project-based learning (PBL) is a pedagogical approach that stresses the process of learning, rather than the individual facts that are learned. According to PBLworks, an organization that promotes and helps schools implement PBL, "Project Based Learning is a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge" (PBLworks, 2020). The organization also states that project-based learning stresses skills like collaboration, communication, problem solving, and critical thinking (PBLworks, 2020). The following studies refer to PBL practices (Table 5).

Table 5: Project-based Learning studies from Teacher Resource Center

Table 5: Project-based Learning studies from Teacher Resource Center		
Study	**Summary**	**Practices**
Realizing the Promise of Project-Based Learning (Revelle, Wise, Duke, & Halvorsen, 2019)	Project based learning programs that have shown to be effective have some identifying features. In this study, students increased their reading skills, writing skills, and mastered social studies content/skills by developing brochures about their local community.	• Authentic projects situated in the real world • Students engage in individual and group activities • Teachers act as coaches and guides • Students use their products with real world audiences • Publishing tools or integrations
Collaborative project-based learning: An	Many project based learning programs involve student	• Digital collaboration features

integrative science and technological education project (Baser, Ozden, & Karaarslan, 2017)	collaboration. When students were given access to an online forum, their collaboration skills increased.	• Communication tools for students
USING THE LAND: A project-based learning activity to determine how best to redevelop the site of a demolished shopping mall (Nagle & Pexore, 2018)	They used a real world example and project based learning to teach an interdisciplinary unit on environmental science, engineering concepts, math, and government.	• A research notebook to store digital artifacts and notes • Project management features to assist with a long term project • The ability for different students/groups to use different materials • Flexible work products determined by students • Rubrics for flexible work products
Exploring the effects of project-based learning in secondary mathematics education (Holmes & Hwang, 2016)	In this study, all students benefited from learning math in a project based learning format that included collaboration, communication, and presentation. Low performing students performed better in the PBL environment	• The ability to do mathematics equations in text boxes and other content creation areas
A Study of Student Engagement in Project-Based Learning Across Multiple Approaches to STEM Education Programs (Hall & Miro, 2016)	This case study analyzed several different PBL programs for evidence of PBL strategies. The list of strategies was helpful to identify practices that could be adopted in an LMS.	• Teacher acts like a coach or facilitator (little direct instruction) • Cooperation and collaboration • Verbal and written feedback

		• Higher level questioning • Interdisciplinary • Students self-assess for formative learning

When identifying the teaching and learning practices mentioned in research studies on PBL, it became clear that the foundations come from constructivism. All of the studies mentioned similar strategies to the ones that were identified in the constructivism section of Table 3. They did mention some more detailed strategies that I noted, like tools to publish documents for use in real world situations, project management tools, rubrics for performance assessments, and content that is interdisciplinary. Looking for these and other constructivist functions in LMS will be necessary to know if they can support PBL.

Social Emotional Learning (SEL) has become very popular in schools, as more and more teachers realize that social interaction and understanding emotions are crucial for students to be successful. An organization focusing on SEL, CASEL, defines it as "Social and emotional learning (SEL) is the process through which children and adults understand and manage emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions" (CASEL, 2020). SEL content seems so different from academic content, that there may be specific teacher and student activities that are important to consider for LMS. The following studies refer to SEL practices (Table 6).

Table 6: Social Emotional Learning studies from Teacher Resource Center

Table 6: Social Emotional Learning studies from Teacher Resource Center		
Study	**Summary**	**Practices**
Indiana Social-Emotional Learning Competencies: A Neurodevelopmental, Culturally Responsive Framework (Oliver & Berger, 2020)	This literature review describes the research on social emotional learning and lists the competencies that students should master. It also lists the way they can be integrated into schools.	• SEL is integral to learning, and many schools have school counselors that can help. • Integration of SEL into academic subjects • Mental health and well-being • Whole child practices so that each student is "healthy, safe, engaged, supported, and challenged." • College and career skills • 21st century skills • School culture and climate • Character education
Advancements in the Landscape of Social and Emotional Learning and Emerging Topics on the Horizon (Schonert-Reichl, 2019)	The article is a literature review of all of the social and emotional learning articles in the journal's issue. One of the biggest themes is that SEL can be taught and assessed, which has lots of implications for	• Teaching SEL concepts in a curriculum helps students build SEL skills • Different students need different SEL supports

	learning management systems.	• Addressing SEL skills can help performance in academic subject areas
Challenges and Opportunities in the Applied Assessment of Student Social and Emotional Learning (Mckown, 2019)	This study describes all of the SEL assessments that are available as of 2019.	• Self-reporting assessments of SEL skills and scenarios • Rating scales of SEL skills and scenarios • Direct assessment of SEL skills
RULER: A Theory-Driven, Systemic Approach to Social, Emotional, and Academic Learning (Brackett, Bailey, Hoffmann, & Simmons, 2019)	This article describes an effective social and emotional learning framework and program (called RULER) that includes tools that can be used on technology platforms.	• SEL curriculum can be delivered online • Students should constantly reflect on their own emotions • Students should build meaningful and deep relationships with adults and peers

The studies on SEL refer to features that align closely with the identity component of the science of learning and development. One basic SEL strategy that surfaced was to have an SEL curriculum in place. But in addition to that, strategies like SEL-based data collections, access to trusted peers and adults, and mental health and well-being stood out as very different than the other two pedagogical approaches we studied, personalized learning and project-based learning. SEL seemed to have some

components of academic knowledge (like a curriculum) but mostly centered on how to support students to be successful in school and interact with the school community.

The popularity of these pedagogical approaches means that teachers are actively looking for tools that help accomplish these tasks. These practices, along with the learning theories I investigated earlier, have surfaced strategies that many learning management systems could leverage into feature designs if they haven't already.

Learning Management Systems

The purpose of this investigation is to judge whether learning management systems contain the features and tools required to implement strategies outlined by the science of learning and development, the foundational learning theories, and popular pedagogical approaches. Now that we have identified many such practices, we can turn our attention to LMS and their features.

Surprisingly, many papers that study LMS do not spend much time defining the term. Oskan, Koselar, and Baykal (2009) and Mcgill and Klobas (2009) use a very general definition, saying that learning management systems are a collection of tools that can organize and facilitate online learning or e-learning. Lonn & Teasley (2009) provide a slightly more specific definition, saying that they are systems that facilitate sharing of instructional materials, making announcements, submitting and returning work, and communication between teachers and students. Lonn & Teasely (2009) also mention that LMS are sometimes called course management systems or CMS. Oskan, et al. (2009) mention that most research studies use LMS, e-learning systems, online learning systems,

and web based learning (WBL) systems interchangeably. It seems that the definition of the term “learning management system” may not hold any clues about the teaching and learning strategies within them.

I used three different strategies to research the features of LMS: a peer reviewed article on LMS platforms, a popular practitioner website, and the four most popular K-12 LMS platforms. When reading through all of the listed features, I found that some of them were designed specifically for a particular function in teaching and learning and others were generic and could be leveraged for multiple strategies. Moreover, I found that both teachers and students could be users of the feature. For each feature, I noted if it was specifically designed for a teaching and learning strategy, a generic feature that could be leveraged for multiple strategies, and what types of tasks teachers and learners could accomplish with the features. I started with an article, Ülker and Yılmaz (2016), which summarized the basic features of LMS (Table 7).

Table 7: LMS Features (Ülker & Yılmaz, 2016)

Table 7: LMS Features (Ülker & Yılmaz, 2016)				
Feature	**Description**	**Specific or Generic**	**Teacher Experience**	**Learner Experience**
Users	Different roles have different functionality and permissions in LMS. Typical users are administrators, teachers, and students.	NA - This function just creates the user types	NA - Teachers are a user type in most LMS.	NA - Learners are a user type in most LMS.
Courses	The highest organizational unit in an	Generic - Courses can contain	Teachers are typically	Learners experience courses

	LMS is a course, which is where content and materials are stored. It often can be subdivided into topics, units, time intervals, etc.	multiple teaching and learning strategies	responsible for designing courses using the generic features.	as designed by teachers.
Exams	Some type of module for assessing students is included.	Generic - Assessments can match the practice or performance strategy the teacher wants to use	Teachers design exams and deliver to students.	Learners can complete exams after they are designed by the teacher.
Assignments	Some way to assign work and receive completed work is included. There is typically a way to evaluate the work as well.	Generic - Assignments can match any teaching and learning strategy	Teachers create or curate assignments and deliver to students.	Learners complete the assignments assigned to them by the teacher.
Reports	There are reports for each type of user. These reports include performance/grades, usage, progress, etc.	Generic - This function pulls and displays data generated by the other functions. The data could be formatted to match a number of different teaching and learning strategies.	Teachers can view a set of reports to help them understand student performance and usage.	Learners can view a subset of reports related to their performance.
Other Features	• Forums • Chat • Polls • Wiki • Video Conference	Generic - These features can be aligned to any teaching and learning strategy.	Teachers can leverage these features to encourage or require communication, collaboration, or and evaluation.	Students can use these features as expected by teachers, but can also use them for their own communication and collaboration desires.

From this first resource, the features were presented in generic categories that teachers could use for many different purposes. The way teachers set up their course could be aligned to a number of different teaching and learning strategies. However, the expectations must be communicated by the teacher to the learner due to the generic nature of the features. Students typically use features in an LMS after they have been prepared or set up by the teacher, but there are some features that can be used on their own in a flexible way. These are typically the communication and collaboration features, which are generic in that they are not aligned to specific teaching and learning strategies.

When searching on Google, I noticed that there are a lot of websites that discuss LMS tools. One of the most popular in search results are articles written in http://elearningindustry.com, a practitioner website that discusses elearning tools and practices. This website also lists the features of LMS, so I investigated their feature list with and did the same analysis regarding the specific or generic nature, what teachers can do with the feature, and what learners can do with the feature (Table 8).

Table 8: LMS Features (Sharma, 2017)

Table 8: LMS Features (Sharma, 2017)				
Feature	**Description**	**Specific or Generic**	**Teacher Functions**	**Learner Functions**
Managing the learning experience	Managing users, courses, and roles and being able to	Generic - This is the course experience and the reports on performance and usage.	Teachers are typically responsible for creating courses.	Learners engage with the course as designed by teachers.

	access data reports.			
Making a course calendar	These features help to organize the time/dates associated with course assignments.	Generic - The calendar reflects dates associated with course assignments.	Teachers can assign dates based on their preferences and/or requirements from the institution.	Learners can see dates for teacher assignments and may also be able to create events in some LMS.
Communications	Sending messages and notifications between teachers and learners	Generic - Messaging can be used for any purpose.	Teachers can exchange messages to all students, groups of students, or individual students.	Learners can send messages to other learners and to teachers.
Assessment	Evaluating work completed in the course or taking quizzes	Generic - Many different assessment types can be delivered through LMS.	Teachers select or design assessments and deliver them through the LMS. They can also evaluate the assessments.	Students can complete assessments once they have been assigned by teachers.
Transcripts, records, and certifications	The ability to track the performance of learners across topics, courses, etc.	Generic - The institution typically designs these reports that pull data from learner performance metrics and display them in transcripts, records, and certifications.	Teachers typically do not have control over these features, but do the evaluation that supplies the data to these reports.	Students are the recipients of these reports.
Managing competencies, standards, etc.	The ability to organize what is learned in the course with existing learning frameworks.	Generic - The institution selects or creates the competency and standards frameworks, which can match any pedagogical approach.	Teachers typically have to select or create assessments and assignments that align to the competencies and standards selected by the institution.	Learners may engage with competencies and standards if the assignments or assessments refer to them. They may also see them in reports, transcripts, certifications, etc.

Administration	Back end admin of the software	NA - These features relate to the information technology needs of the implementation	Teachers do not interface with these features, but their experiences may be guided by them.	Learners do not interface with these features, but their experiences may be guided by them.

While the practitioner account listed a few more individual features than the research article, the lists were very similar. The first theme that is beginning to develop is that LMS features are typically designed to be generic, so that teachers can choose their own pedagogical approaches to deliver in the system. The second theme is that most features are prepared and delivered by teachers to students, although some features around communication and calendar may be used flexibly by students.

The next investigation is to look at the actual features of some LMS platforms. I searched for sources that tracked the most popular K-12 LMS platforms. Menard (2020) conducted a market analysis of K-12 LMS in thousands of school districts in the United States and Canada. They found that the four most popular LMS platforms were Canvas, Google Classroom, Moodle, and Schoology. I conducted the same investigation as the research study and practitioner website by analyzing if the features of these four platforms were generic or specific in terms of teaching and learning strategies and described the teachers and learner experiences. In Table 9, I summarized this research. The name of each feature defaults to what the Canvas LMS uses, since that was the first platform I analyzed.

Table 9: List of Basic Features (Canvas, 2020; Schoology, 2020; Moodle, 2020; Google Classroom, 2020)

Table 9: List of Basic Features (Canvas, 2020; Schoology, 2020; Moodle, 2020; Google Classroom, 2020)					
Feature	**Description**	**LMS(s)**	**Generic or Specific**	**Teacher Experience**	**Learner Experience**
Analytics	Data reports about usage in the system, grades, etc.	Canvas, Schoology, Moodle	Generic - This function pulls and displays data generated by the other functions. The data could be formatted to match a number of different teaching and learning strategies.	Teachers can view a set of reports to help them understand student performance and usage.	Learners can view a subset of reports related to their performance.
Announcements	The ability to push out messages to the entire class	Canvas, Schoology, Moodle	Generic - The messages can contain any text or media content.	Teachers create the messages that are sent to the whole class.	Students can read the messages sent out to the whole class, but cannot do this themselves.
Assignments	The ability to create, complete, and evaluate class work	Canvas, Google Classroom, Schoology, Moodle	Generic - Assignments can match any teaching and learning strategy.	Teachers create or curate assignments and deliver to students.	Learners complete the assignments assigned to them by the teacher.
Calendar	Integration of a calendar to organize course	Canvas, Google Classroom, Schoology, Moodle	Generic - Dates can be associated with assignments using any teaching and	Teachers can assign dates based on their preferences and/or requirements from the institution.	Learners can see dates for teacher assignments and may also be able to create events

			learning approach.		in some LMS.
Canvas Commons	A resource repository and sharing portal	Canvas	Generic - Any type of teaching and learning document can be shared.	Teachers can post resources and see resources in this product.	Students cannot access this feature.
Chat	Real-time text-based communication	Canvas, Google Classroom, Schoology, Moodle	Generic - Messaging can be used for any purpose.	Teachers can exchange messages to all students, groups of students, or individual students.	Learners can send messages to other learners and to teachers.
Collaborations	Students can work on the same document at the same time	Canvas, Google Classroom, Schoology, Moodle	Generic - Many teaching and learning strategies can be used.	Teachers can create assignments for groups of students to complete together.	Once assigned, a learner can complete a work product in a group.
Conferences	This tool allows for video and audio conferencing	Canvas, Google Classroom, Schoology, Moodle	Generic - The class can have discussions with or without the guidance of teachers.	Teachers can schedule audio and video conferences with the class.	Learners can participate in conferences and can sometimes schedule their own conferences with peers or teachers.
Course Import Tool	Transfer content from one course to another	Canvas	Generic - This allows course materials from one course to be imported to another.	Teachers (and administrators) can use this feature.	Students cannot use this feature, but may use materials that have been imported.
Discussions	Rich-text and media can be used in class discussions	Canvas, Google Classroom,	Generic - The teacher can use any	Teachers can ask learners to engage in any	Learners can have discussions based on

		Schoology, Moodle	teaching and learning	type of discussion.	teacher requests or are free to drive them on their own.
ePortfolios	Users can document their work across courses	Canvas, Schoology, Moodle	Generic - Any type of work product	Teachers can evaluate portfolios.	Students have flexibility to assemble their own portfolios.
External Apps	Integration of 3rd party tools	Canvas, Google Classroom, Schoology, Moodle	Generic - The external tools could be generic or implement a specific teaching and learning strategy.	Teachers may leverage the tools for students or use tools for their own work.	Learners use tools integrated by the institution or teacher.
Files	A file management system for courses and student work	Canvas, Google Classroom, Schoology, Moodle	Generic - The documents can contain any teaching and learning strategy.	Teachers can organize their own files and see student files.	Learners can see teacher files and organize their own files.
Grades & Gradebook	Evaluations and comments for student work	Canvas, Google Classroom, Schoology, Moodle	Generic - Any evaluation and grading system can be implemented.	Teachers and institutions can decide how to evaluate learners.	Learners can see grades after the teacher evaluates work.
Grading schemes	Specifying a framework for how evaluations translate to grades	Canvas, Google Classroom, Schoology, Moodle	Generic - These settings can match any teaching and learning approach.	Teachers and institutions set the grading schemes.	Student work is graded using the grading scheme, but teachers may have to explain it to learners.
What-If Grades	The ability to calculate grades	Canvas	Generic - Related ro grades and	Teachers do not use this feature.	Students can put hypothetical

	based on hypothetical scores		grading schemes.		numerical scores in the gradebook.
Groups	Build specific groups of students for collaborative work, discussions, etc.	Canvas, Schoology, Moodle	Generic - Groups of students can work together.	Teachers can create groups of students that can accomplish a task together.	Students can collaborate in groups and may be able to form their own groups.
Inbox	Canvas has an internal emailing/messaging system	Canvas, Google Classroom, Schoology, Moodle	Generic - Messaging can be used for any purpose.	Teachers can exchange messages to all students, groups of students, or individual students.	Learners can send messages to other learners and to teachers.
Modules	Courses are separated into modules to organize content	Canvas, Google Classroom, Schoology, Moodle	Generic - Any teaching and learning strategy can be deployed in a module.	Teachers design modules to organize the course.	Student learning path is typically through modules.
Outcomes based or competency based learning	Standards that students need to master	Canvas, Moodle	Generic - Outcomes can match any teaching and learning strategy.	Learner outcomes can be specified by teachers or administrators.	Students can view outcomes and can see teacher evaluations related to outcomes.
Pages	Content is inserted into pages within modules	Canvas, Google Classroom, Schoology, Moodle	Generic - Any teaching and learning strategy can be deployed in a page.	Teachers design pages within modules to organize the course.	Student learning path is typically through modules, which have individual pages of content.
Profile and User Settings	Users have options to set their profile and user experience	Canvas, Google Classroom,	NA - This feature is where personal	Teachers can input information about	Students can input information about

		Schoology, Moodle	information is stored.	themselves for students to see.	themselves for teachers and other students to see.
Question Banks	Assessments can pull questions from pre-prepared question banks	Canvas, Schoology, Moodle	Generic - Questions can reflect any teaching and learning strategies.	Teachers build or use question banks for assessments. Sometimes assessments can pull random questions from assessment banks.	Students only see the assessment, and not the question bank. But they may take assessments that have different questions than their peers.
Quizzes	Assessment engine within the LMS	Canvas, Google Classroom, Schoology, Moodle	Generic - Quizzes can use any teaching and learning strategy.	Teachers create quizzes and deploy to students.	Students complete quizzes designed by teachers.
Rich Content Editor	Within Canvas, users can type and format text in rich-text format	Canvas, Google Classroom, Schoology, Moodle	Generic - Text-based content can follow any teaching and learning strategy.	Teachers use this feature to input text in any LMS function.	Students use this feature to input text in any LMS function.
Attendance Tool	Attendance can be tracked by teachers	Canvas, Schoology, Moodle	NA - Not related to teaching and learning.	Teachers use this feature to track attendance.	Students do not use this feature.
Rubrics	Rubrics can be used to evaluate work	Canvas, Google Classroom, Schoology, Moodle	Generic - Using rubrics to judge performance is a constructivist activity. But the feature is designed to be	Teachers may design rubrics to guide performance assessments and can use them to evaluate as well.	Students can use rubrics to guide their work products and in an evaluation of their work products.

			broad and can be used in different ways.		
Scheduler	Students can sign up for appointments on the calendar	Canvas	Generic - Students can communicate with teachers using any learning strategy.	Teachers can offer times when students can sign up to meet.	Students use this feature to sign up for times with the teacher.
SIS Imports	Student information can be pulled from an SIS	Canvas, Google Classroom, Schoology, Moodle	NA - This is an administrative feature to access student information.	NA	NA
"SpeedGrader"	A whole-class grading function for teachers	Canvas, Schoology, Moodle	Generic - An easier evaluation feature, where the assessments can reflect any teaching and learning strategy.	Teachers use this to grade assignments or assessments for an entire class.	Students do not use this feature.

The LMS feature lists were much more detailed than the articles, but generally reflected similar trends. Most features are generic and need to be set up by teachers before students can use them. Teachers that have a preference for certain teaching and learning strategies, can use generic features to deliver those strategies to students. However, there are typically no internal features that support those strategies. For learners, the generic features where they have control are communication and collaboration. But the student-centered features are small in number. Due to the lack of features that specifically help learners learn according to the science of learning and

development, I am inclined to favor the term “course management system” to describe these tools rather than learning management system, as identified by Lonn and Teasely (2009). There has been no mention of LMS supporting learners the way the science of learning and development explains.

Learning Management Systems 2.0

In this report, I first explored how people learn from the science of learning and development, with an added focus on cognition. I then studied pedagogy by focusing on learning theories and popular pedagogical approaches. This investigation produced dozens of teaching and learning strategies that are supported by the research. In this section, I share the features I identified that could potentially be built into an LMS (see Table 10).

Table 10: LMS Features Based on Learning and Teaching Research

Table 10: LMS Features Based on Learning and Teaching Research	
Feature Set	**Explanation and Specific Features**
1. Student Learning Productivity Suite	Most LMS have a student home page, but it usually just helps the student to launch courses. The student home page should be a place where students manage their own learning that is separate from their courses. This is inspired by the science of learning and development. Some of the features that could be: • Short term and long term goal setting, planning, tracking progress, creating and modifying milestones, and reflection. These features should

	be available within a single course and across all courses and years. • Study tools that reflect practices encouraged in the science of learning and development like repeated practice, relating new information to previous knowledge, etc. • A place to document personal interests and store related information. This can be leveraged for work within courses as well. • Metacognitive tools like concept maps, outlines, summaries, reflections, self-assessment, etc. • A feature similar to a wiki where students can track knowledge so that they can activate previous knowledge when learning new topics • Self-assessment for social emotional skills • Ability to communicate with and request guidance/coaching from teachers, counselors, and peers for issues regarding academics, SEL, identity, etc. • Ability to store personal life experiences, strengths, and struggles and share them with teachers so that they can be incorporated in the learning experience. • Create real world applications of content like written and video blogs, podcasts, social media posts, etc. • Follow and incorporate content from experts that align to the students personal interests • A detailed dashboard of skills for each student • A different user experience and set of tools based on the age and developmental level of the student
2. Teacher tools aligned to Science of Learning and Development	In LMS, teachers have many features on how to design the learning environment, curate content, create assignments, create assessments, etc. There should be guidance from the science of learning and development embedded in these features, like: • Manage cognitive load • Make learning relevant, engaging, and appropriately challenging for each student • Give timely and meaningful feedback

3. Behaviorism	Teachers may want to include some features that align to behaviorism like: • Rewards and feedback to reinforce behaviors • Pre/post assessments • Alerts and reminders (cues) • Sequencing and chaining of related tasks
4. Cognitivism	Teachers may way to include some features that align to cognitivism like: • Feedback to guide and support • Metacognitive activities • Information organizing techniques • Activating previous and prerequisite knowledge
5. Constructivism	Teachers may way to include some features that align to constructivism like: • Real world situations • Apprenticeships and examples of expert performance • Debates and discussions • Students doing research and finding content • Provide information in several different formats • Performance assessment • Authentic assessment
6. Personalized Learning	Teachers may way to include some features that align to personalized learning like: • Interviews, surveys, and assessments to find unique interests and skills of students • Information about each student organized into a student profile that can be accessed by teachers. • Allow students to find their own way of showing what they know • Allow students to progress at their own pace (mastery based or competency-based progression) • Digital literacy tools • Adaptive technologies • Personalized learning paths for students depending on needs

7. Project-Based Learning	Teachers may way to include some features that align to project-based learning like: • Projects situated in the real world • Individual and group activities • Guide and coach students (more frequent communication) • Real world audiences • Publishing tools and integrations • Student collaboration and communication • Research notebook • Project management • Authentic and performance assessments • Rubrics • Verbal and written feedback • Interdisciplinary
8. Social Emotional Learning	Teachers may way to include some features that align to social emotional learning like: • SEL curriculum • SEL skills included in all academic areas • Self-reporting SEL assessments • Rating scale SEL assessments • Direct SEL assessments • SEL self-reflections • Communication between students and peers to build strong, healthy, and productive relationships

Comparing these features (i.e., Table 10) with my LMS investigation, a number of gaps emerged in the top four most popular LMS: Canvas, Google Classroom, Schoology, and Moodle. The first gap is that none of the platforms have anything resembling a suite of tools for students to manage their own learning. The second gap is that teachers do not have tools or guidance to manage learning as suggested by learning science, like how to manage cognitive load or building connections between content to help encoding. Third,

looking at the three learning theories, LMS have generic features where many of the associated teaching and learning strategies can be implemented. However, it is up to the teachers to design and explain those strategies to students within the generic framework of the platform. There is very little way to implement the strategies holistically across assignments and courses without the teacher's inventiveness. For example, activating previous knowledge is important in cognitivism, but there is no way to organize and search for all relevant content across modules and courses like professional knowledge management and tagging platforms. This generic trend continues with the popular pedagogical approaches: personalized learning, project-based learning, and social emotional learning. For example, creating a learner profile of student interests, strengths, and weaknesses for personalized learning needs a more formal set of features that pulls data from other places, even though generic features could be used to gather student interests or assessment scores. Having a project management feature set for students to organize a project-based learning unit may also need more specific features. While teachers could use the generic assessment features to engage in social emotional learning strategies, the SEL self-reflection component may not be as productive in the gradebook where assessment evaluations are stored. In summary, the generic features in LMS allow for most teaching and learning strategies to be implemented. However, more specific features aligned with specific pedagogical aims could help the teaching and learning strategies be implemented more efficiently.

There are many more LMS that are being used in schools, and I was curious to see if there are platforms that diverge from the trend above. So I selected other LMS from Menard's (2019) market analysis, EdSurge's Product Index (2020), and Google searches to find and research more LMS platforms. I wanted to see if they contained features to address the teaching and learning strategies in Table 10. In Table 11, I have listed many LMS and whether they fully, partially, or do not cover the teaching and learning strategies in Table 10.

Table 11: LMS Features Based on Teaching and Learning Strategies from Table 10

Table 11: LMS Features Based on Teaching and Learning Strategies from Table 10

Legend: Yes | Partial | No

Popular K-12 LMS	Student Learning Productivity Suite	Teacher tools aligned to Learning Science	Behaviorism	Cognitivism	Constructivism	Personalized Learning	Project-Based Learning	Social Emotional Learning
Altitude Learning (2020)	No	No	Yes	Partial	Partial	Yes	Partial	No
Blackboard Coursesites (2020)	No	No	Yes	Partial	Partial	Partial	Partial	No
Blackboard Learn (2020)	No	No	Yes	Partial	Partial	Partial	Partial	No
D2L (2020) Brightspace	No	No	Yes	Partial	Partial	Yes	Partial	No
Canvas (2020) Free Account	No	No	Yes	Partial	Partial	Partial	Partial	No

Canvas (2020) School or District	No	No	Yes	Partial	Partial	Partial	Partial	No
Empower Learning (2020)	No	No	Yes	Partial	Partial	Yes	Partial	No
Foundry (2020) Forge	Partial	No	Yes	Partial	Yes	No	Yes	No
Foundry (2020) Transform	Partial	No	Yes	Partial	Yes	Yes	Yes	No
Google Classroom (2020)	No	No	Yes	Partial	Partial	No	Partial	No
Headrush (2020)	No	No	Yes	Partial	Yes	Yes	Yes	No
Itslearning (2020)	No	No	Yes	Partial	Partial	Yes	Partial	No
Kiddom (2020) (free for teachers)	No	No	Yes	Partial	Partial	Partial	Partial	No
Kiddom (2020) for Schools	No	No	Yes	Partial	Partial	Partial	Partial	No
Microsoft (2020) Teams	No	No	Yes	Partial	Yes	Partial	Yes	No
Moodle (2020)	No	No	Yes	Partial	Partial	No	Partial	No
My Learning Collaborative (2020)	Partial	No	Yes	Partial	Partial	Yes	Partial	No
Novare (2020)	No	No	Yes	Partial	Yes	Partial	Yes	No
Otus (2020)	No	No	Yes	Partial	Partial	Partial	Partial	No
Schoology (2020a) Free Basic	No	No	Yes	Partial	Partial	Partial	Partial	No
Schoology (2020b) Enterprise	No	No	Yes	Partial	Partial	Partial	Partial	No

Seesaw (2020a) (free for teachers)	No	No	Yes	Partial	Yes	No	Yes	No
Seesaw (2020b) for Schools	No	No	Yes	Partial	Yes	No	Yes	No

Reviewing this larger set of tools, it is clear that the features actually do vary quite a bit between platforms. This suggests that many LMS intentionally build features to differentiate their offerings from the four most popular LMS, perhaps in some cases driven by the need to cover more specific teaching and learning strategies. After studying the group of twenty-three different LMS platforms, I noticed the following trends:

- Only 3/23 have features designed around student needs for productive learning
- 0/23 contain framing for teachers on the science of learning and development
- 23/23 contain strategies that reflect behaviorist approaches
- 23/23 contain a partial set of features that promote cognitivism. When I was researching the platforms, the main features that were missing were activating prior/prerequisite knowledge (with an embedded feature in the LMS, rather than just asking students to remember) and built-in tools to aid metacognitive processes.
- Most platforms had a partial set of constructivist features, particularly the ability to grade projects using a rubric. The main features that are missing

were real world situations, project management and organization tools, etc. 7/23 were specifically designed with constructivist principles in mind (including those from project-based learning).

- Many platforms have some kind of personalized learning feature set, including 7/23 having a full range of features. The main features that are missing are competency-based progression, instruction based on interests and passions, and student agency and choice.
- 0/23 of the platforms reported having social emotional learning features.

After completing the review, I was disappointed that more tools did not have features that are supported by so much research. Effectively, teachers have to find ways to implement their planned pedagogical strategies using the generic features of an LMS. Moreover, students do not get a chance to leverage the LMS in ways that would help their own learning across all of their courses.

Recommendations

Selecting and implementing technologies like LMS is part of an instructional design process. “Instructional design is intended to be an iterative process of planning outcomes, selecting effective strategies for teaching and learning, choosing relevant technologies, identifying educational media, and measuring performance” (Branch & Kopcha, 2014). Teachers and school leaders use this process to manage how teaching and learning environments are designed in schools. To be able to accomplish this, teachers need the knowledge and skills to design learning environments. Moreover, when LMS

have generic and flexible tools, teachers can also flexibly use systematic eclecticism to change teaching and learning strategies when needed. So the first recommendation I have, based on all of the research on instructional design, is that educators should drive the process to select and implement LMS based on the selected teaching and learning strategies.

After researching the features of LMS platforms, I also suggest how educators could select LMS based on the teaching and learning strategies that they prioritize. I believe that teachers should search for LMS that have turn-key features aligned to specific teaching and learning strategies from the science of learning and development, learning theories, and popular pedagogical approaches. My opinions are based on a belief that knowledge about high quality instructional design is needed to implement a wide variety of teaching and learning strategies in LMS, and that some LMS can help teachers in the process. One example is project-based learning. While PBL can be implemented in any learning management system, LMS like Headrush have specific tools that are designed to facilitate teaching and learning strategies aligned with project based learning. For example, in project based learning, students must manage tasks and work products over a period of time. The Headrush LMS includes an agile planning function where students can dynamically plan their project in an authentic, real-world way like professional project management software like Asana or Trello. In the student experience, students can create, drag, and drop task cards between the research phase, prototyping phase, work product phase, and a completed phase (Headrush, 2020). This

feature is in the student experience and does not have to be created by the teacher. Moreover, allows students to manage projects in a similar way to professionals. This type of project management is possible in a generic LMS, but the teacher may have to use spreadsheets or other text based methods for students to independently track work progress.

I also recommend that more LMS companies include specialized functionality like Headrush. Headrush chose project management functionality for students within project based learning, but this investigation has surfaced so many more teaching and learning strategies that can be incorporated in LMS this way. One request I have heard from working with schools is for LMS to include goal setting and reflection features. In my professional life, I worked with a school district in California that uses Canvas as their LMS and would like to do goal setting and reflection. Their solution is to use Google Docs integrated within Canvas and teachers will individually consult each student's Google Doc every week. I suggested tools like Sown to Grow, where students can set goals for academics and SEL, and reflect on their progress while teachers have an actionable dashboard to help them check in with students (Sown to Grow, 2020). However, they were not able to add a new product due to cost. I checked the LMS market and saw the Foundry has a goal setting and reflection feature for students (Foundry, 2020). Switching LMS platforms was not an option either. It will be interesting to see if these smaller LMS platforms with specialized features can compete with the big players

or integrate their components into LMS platforms. The top four platforms have about three quarters of the market (Menard, 2019).

Conclusion

After investigating the science of learning and development, learning theories, and popular pedagogical approaches, I believe that LMSs could do more to explicitly align with the science of learning and development, learning theories, and pedagogical approaches. While teachers may use instructional design processes to successfully leverage popular LMS for many different teaching and learning strategies, some teachers may not have such knowledge and the process could be a lot easier with explicit scaffolds built into the LMS. I also believe that students have leveraged LMSs to engage in deep learning when teachers use their expertise to design rigorous instructional activities. However, LMSs could also contain more powerful tools to help students organize their learning within courses and across all of their courses so that they can develop important learning practices, habits and skills. We discussed that Lonn and Teasely (2009) mention that LMS are sometimes called course management systems or CMS. CMS might be a better term for some LMS that use mainly generic features. I recommend reserving the terms LMS for platforms that explicitly incorporate approaches to learning.

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